

NASA Range Safety Program 2006 Annual Report

STATUS REPORTS JOHNSON SPACE CENTER LAUNCH CONSTELLATION RANGE SAFETY PANEL

Late in 2005, it became increasingly clear that there were many questions and issues related to range safety that needed to be coordinated across the multiple [Constellation Program](#) Projects and organizations. It was time to start addressing some of the early design and requirements issues and open a coordinated dialog with the 45th Space Wing on NASA's new vision and objectives.

In February 2006, the Launch Constellation Range Safety Panel was officially chartered by the Constellation Program and jointly signed by the 45th Space Wing Commander and the program manager.

Highlights of the Launch Constellation Range Safety Panel Charter

Highlights of the Launch Constellation Range Safety Panel charter are included below.

I. PURPOSE: This directive establishes the manner in which launch range safety matters will be managed for Constellation program vehicles, including specifying key interfaces with the Department of Defense for launch range safety (primarily the Air Force 45th Space Wing responsible for the Eastern Range).

II. SCOPE: All Range Safety activities for elements of Constellation launch vehicle flights and pre-operational test flights are within the scope of this directive. The Launch Constellation Range Safety Panel will:

- Serve as the technical forum to facilitate formulation and joint approval of NASA/Air Force Range Safety policy agreements
- Identify Range Safety requirements and propose tailoring, as required
- Support risk model and analysis tool development (formulation, assumptions, and input data)
- Integrate Range Safety related hardware and software changes
- Monitor Range Safety System design, testing, and implementation
- Initiate and integrate operational Range Safety activities such as operational concepts and procedures, analysis of trajectory design variations, mission planning, flight rules and launch commit criteria development

Note: Entry vehicle range safety is addressed in another directive.

V. ORGANIZATION: The Launch Constellation Range Safety Panel is comprised of NASA and Air Force representatives and is the forum for range safety coordination and negotiations between the agencies. The Launch Constellation Range Safety Panel is co-chaired by the 45th Space Wing Range Safety Manager and the NASA Constellation Range Safety Manager. In addition to the chairperson, NASA membership on this panel includes representatives from the following:

- Launch Vehicle Project
- Crew Exploration Vehicle Project
- Kennedy Space Center Constellation Ground Operations Project and Range Safety Representative

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- Johnson Space Center Flight Design and Dynamics, Flight Director Office, Astronaut Office, Constellation Operations Integration, and Constellation Systems Engineering and Integration
- Headquarters Constellation Integration and Analysis and Safety, Reliability, and Quality Assurance

In addition to the 45th Space Wing Range Safety Manager, Eastern Range membership on this panel includes representatives from the following 45th Space Wing organizations:

- Range Operations Squadron
- Launch Analysis
- Launch Safety and Analysis

The Launch Constellation Range Safety Panel has strong representation from all of the key program elements and has been very active since its inception. By the end of 2006, the panel had met 15 times, plus supported multiple splinter meetings, and one face-to-face in Florida.

Launch Constellation Range Safety Panel Trajectory Working Group

The first sub-group from the Launch Constellation Range Safety Panel was the Trajectory Working Group. This group coordinates the range safety trajectory analysis requirements and manages the distribution of the tasks and products across the multiple centers. We have effectively tapped the trajectory expertise from Marshall Space Flight Center, Johnson Space Center, Glenn Research Center, and Langley Research Center.

The Trajectory Working Group is overseeing which of the complex simulation models will be used and managing the multitude of trajectory baseline assumptions. Currently, we have a long list of analysis tasks that must be completed to feed into the development of the risk estimation models. The team is primarily focused on meeting the requirements to support the ARES I-1 test flight, currently scheduled for 2009.

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ARES I-1 Support

The [ARES I-1](#) test flight is designed to re-use many Space Shuttle solid rocket booster components while demonstrating the Constellation Program's progress in stepping into the new vision.

The flight test vehicle configuration shown to the right will consist of a four-segment solid rocket booster with a dummy fifth segment, as well as a dummy shell for the upper stage and crew exploration vehicle. The flight will demonstrate only the first stage of flight, resulting in a sub-orbital trajectory and an Atlantic Ocean disposal of all of the components.

Other Topics Considered

Many non-trajectory topics needed the Launch Constellation Range Safety Panel's attention this past year. The baseline design for the Constellation includes re-using the Shuttle flight termination system. However, this configuration poses possible complications described below.

Flight Termination System Frequency. The National Telecommunications and Information Administration directed all ranges to shift flight termination system frequency from 416.6 megahertz to 421 megahertz region by end of 2006. In September 2006, the Administration formally granted the Space Shuttle Program a waiver to continue flight termination system support at the current frequency through the end of Shuttle program in 2010.

However, this waiver is applicable to the Space Shuttle only. Near the end of the year, it is thought that the Air Force will to be granted a waiver by the National Telecommunications and Information Administration to continue to use the 416.5 megahertz frequency through the end of 2010. Once formalized, the ARES I-1 flight will be covered by that waiver and reuse of the Shuttle flight termination system frequency will remain the plan.

Aft Segment Linear-Shaped Charge. As noted above, the ARES I-1 plan was to totally reuse the Shuttle solid rocket booster components and accept the fact that the aft segment does not have a linear-shaped charge. For the Space Shuttle, approximately 90 percent of the launch area risks are driven by the threat of an intact aft segment impacting on land and generating a large overpressure hazard.

Though not fully quantified for ARES I-1, the majority of the Launch Constellation Range Safety Panel membership recommended that we amend the test flight design to include the charge extension and strive to achieve significant risk reduction. This topic has been addressed at numerous Launch Constellation Range Safety Panel meetings and was presented to the Program manager just before the Christmas holiday.

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Constellation Program Manager, Jeff Hanley, made the following decisions:

- I would like to recommend to the flight test team that they plan to incorporate a requirement for adding flight termination functionality to the aft segment of the first stage on Ares I-1.
- Candidate design options should be included in the upcoming flight test vehicle preliminary design review; schedules adjusted as necessary.
- The Range Safety Panel will continue with planned malfunction turn analyses to be completed by late spring.
- Design options are preferred that would allow deletion of this capability (for the purpose of recovering schedule) in the event future analyses indicate a defensible technical case can be made for either meeting the NASA procedural requirement for casualty expectation (E_c) or waiving it, if the program should chose to pursue that.

It was greatly appreciated that program management was responsive to the questions and concerns raised concerning this topic while at the same time considering the project's direct critical schedule and cost impacts.

Overall, this has been a very productive and dynamic year for the Launch Constellation Range Safety Panel. Due to the high level of cooperation and professionalism exhibited by the panel members, the integration of the multiple centers and agencies has been successful. This next year promises many challenges focused on supporting the ARES I-1 test flight, as we perform a number of analyses, engage in detailed tailoring negotiations to satisfy Air Force and NASA requirements, and further establish the relationship with other projects.